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ORIGINAL RESEARCH

Home-Based Walking Exercise in Peripheral Artery Disease: 12-Month Follow-up of the Goals Randomized Trial

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***Background*—**We studied whether a 6-month group-mediated cognitive behavioral (GMCB) intervention for peripheral artery disease (PAD) participants, which promoted home-based walking exercise, improved 6-minute walk and other outcomes at 12-month follow-up, 6 months after completing the intervention, compared to a control group.

***Methods and Results*—**We randomized PAD participants to a GMCB intervention or a control group. During phase I (months 1 to 6), the intervention used group support and self-regulatory skills during weekly on-site meetings to help participants adhere to home-based exercise. The control group received weekly on-site lectures on topics unrelated to exercise. Primary outcomes were measured at the end of phase I. During phase II (months 7 to 12), each group received telephone contact. Compared to controls, participants randomized to the intervention increased their 6-minute walk distance from baseline to 12-month follow-up, (from 355.4 to 381.9 m in the intervention versus 353.1 to 345.6 m in the control group; mean difference=+34.1 m; 95% confidence interval [CI]=+14.6, +53.5; $P<0.001$) and their Walking Impairment Questionnaire (WIQ) speed score (from 36.1 to 46.5 in the intervention group versus 34.9 to 36.5 in the control group; mean difference =+8.8; 95% CI=+1.6, +16.1; $P=0.018$). Change in the WIQ distance score was not different between the 2 groups at 12-month follow-up ($P=0.139$).

***Conclusions*—**A weekly on-site GMCB intervention that promoted home-based walking exercise intervention for people with PAD demonstrated continued benefit at 12-month follow-up, 6 months after the GMCB intervention was completed.

***Clinical Trial Registration*—**URL: ClinicalTrials.gov. Unique identifier: NCT00693940. **(*J Am Heart Assoc*. 2014;3:e000711 doi: 10.1161/JAHA.113.000711)**

Key Words: behavior change • exercise • mobility • peripheral artery disease • physical functioning

Supervised treadmill exercise significantly improves walking performance in people with lower-extremity peripheral artery disease (PAD).[1–4] However, 3 times weekly travel to the medical center for supervised exercise is burdensome for people with PAD and medical insurance does not cover supervised treadmill exercise. Thus, most people with PAD do not participate in supervised treadmill exercise programs.[5] In addition, whether benefits from supervised treadmill exercise are sustained after PAD patients complete a supervised exercise program is unclear. Identifying a walking exercise program that does not require 3 times weekly travel to the medical center and achieves sustained improvement in walking performance over long-term follow-up is an important treatment goal for people with PAD.

In the Group Oriented Arterial Leg Study (GOALS), we recently reported that a 6-month group-mediated cognitive behavioral (GMCB) intervention, consisting of weekly visits to an exercise facility that incorporated group support and self-regulatory skills, helped PAD participants adhere to home-based walking exercise activity and significantly improved their 6-minute walk, treadmill walking performance, physical activity levels, and patient-perceived walking performance.[6] By encouraging PAD patients to integrate walking exercise into their daily routine, the GOALS intervention may provide sustained benefit over long-term follow-up, by promoting adherence to home-based walking exercise even after the

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weekly on-site intervention meetings are completed. We previously reported 6-month follow-up data for the GOALS trial.[6] A secondary aim of the GOALS trial is to determine whether the GOALS intervention was associated with change in 6-minute walk, physical activity, and patient-reported outcomes between baseline and 12-month follow-up, compared to the control group. This report describes results of this secondary aim in the GOALS trial. We hypothesized that PAD patients randomized to the intervention would have significantly better walking performance at 12-month follow-up, 6 months after the on-site intervention was completed, compared to PAD participants randomized to the control group.

Methods

GOALS trial methods have been reported.[7] The institutional review board of Northwestern University Feinberg School of Medicine (Chicago, IL) approved the protocol. Participants provided written informed consent and were randomized to 1 of 2 groups: a GMCB home-based exercise intervention versus attention control group. During phase I (months 1 to 6), participants randomized to the intervention attended weekly on-site group meetings at an exercise center, during which group support and self-regulatory skill instruction were employed to help participants adhere to home-based walking exercise. During phase I, participants randomized to the control group attended weekly on-site group meetings at the medical center, during which they received health educational lectures on topics not related to exercise (Figure 1). Primary outcomes were obtained after phase I, at 6-month follow-up, and results have been reported.[6] During phase II (months 7 to 12), participants randomized to the intervention received telephone calls from their group facilitator (Figure 1). During phase II, participants randomized to the control group received telephone calls from a study coordinator with information related to the educational sessions in phase I.

In this report, we describe results of the secondary aim of the GOALS trial, to determine whether the 6-month on-site GMCB intervention was associated with greater improvement in study outcomes between baseline and 12-month follow-up, compared to the control group. The study was performed in Chicago, Illinois, between July 22, 2008 and May 2, 2013.

Participant Recruitment

Recruitment methods have been reported[6,7] and are summarized here. Participants were recruited through newspaper or radio advertisements, from postcards mailed to people age 65 and older in the Chicago area, and from practicing physicians at Northwestern. People with PAD who had previously

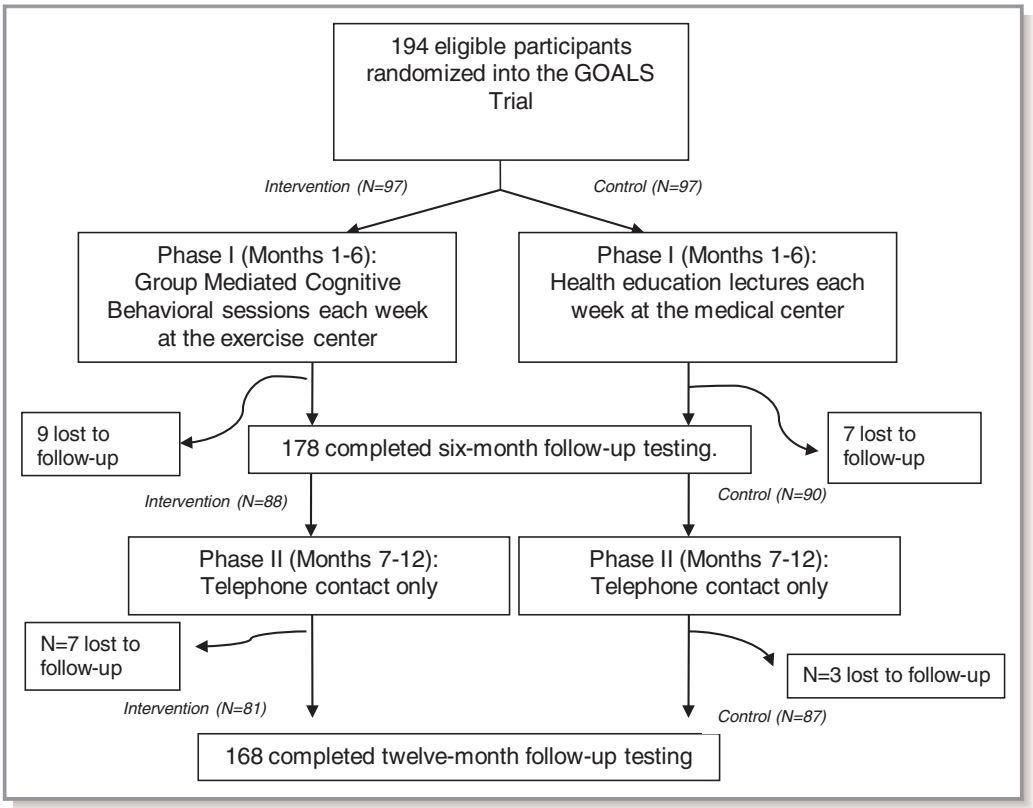

Figure 1. Study design of the Group Oriented Arterial Leg Study (GOALS) trial.

participated in research with the investigative team and expressed interest in future research studies were contacted.

Inclusion and Exclusion Criteria

The inclusion criterion was an ankle brachial index (ABI) ≤0.90 in either leg. Individuals with a resting ABI ≥0.91 and ≤1.00 at baseline were eligible if their ABI dropped by ≥20% after a heel-rise test.[8] Individuals with a resting ABI >0.90 were eligible if they provided medical record documentation of lower-extremity revascularization or evidence of PAD from an accredited vascular laboratory. Exclusion criteria included: below- or above-knee amputation, wheelchair confinement, inability to walk at least 50 feet without stopping, use of a walking aid other than a cane, inability to attend weekly sessions, walking impairment for a reason other than PAD, foot ulcer or critical limb ischemia, and significant visual or hearing impairment.[6,7] Potential participants who did not complete the study run-in had major surgery or lower-extremity revascularization during the previous 3 months or planned during the next 12 months, had major medical illness, or were participating in another clinical trial or had been in another exercise trial or cardiac rehabilitation within the past 3 months were excluded.[6,7] Potential participants with Parkinson's disease, and those requiring oxygen with activity or exercise were excluded.[6,7] Potential participants for whom exercise may be unsafe were excluded. Participants already exercising at a level similar to that targeted in the intervention were excluded. Potential participants with cognitive impairment at baseline were excluded.[9]

ABI Measurement

A hand-held Doppler probe (Pocket Dop II; Nicolet Biomedical Inc., Golden, CO) was used to obtain systolic pressures in the right and left brachial, dorsalis pedis, and posterior tibial arteries using established methods.[2,7,10,11] Systolic pressures of zero were excluded from ABI calculations.

Medical History

Medical history, race, and demographics were obtained using patient report.[2,6,7]

Leg Symptoms

Leg symptoms were characterized using the San Diego Claudication Questionnaire.[12] Most patients with PAD do not have classic symptoms of intermittent claudication.[13] To enhance the generalizability of the GOALS trial, we included eligible PAD participants even if they did not have classic intermittent claudication symptoms.[6,7] Intermittent claudication (IC) was defined as exertional calf pain that does not begin at rest, causes the participant to stop walking, and resolves within 10 minutes of rest.[12,13] Participants without IC were either asymptomatic (ie, reported no exertional leg symptoms) or had leg symptoms not meeting all criteria for IC.[12,13]

Outcomes

All outcomes were measured before randomization and at 12-month follow-up by assessors unaware of participants' group assignment.

Primary Outcome: 6-Minute Walk Test

Following a standardized protocol,[2,6,7,14–16] participants walked up and down a 100-foot hallway for 6 minutes after instructions to cover as much distance as possible. The distance completed after 6 minutes was recorded.

Secondary Outcomes

Physical activity

Physical activity was measured over 7 days using a vertical accelerometer (Caltrac; Muscle Dynamics Fitness Network, Inc., Torrance, CA) according to established, validated methods.[17–19] Because accelerometers were programmed using identical age, weight, and sex for each participant, the measurement yielded "activity units."[17–19] Participants were also asked about the number of city blocks walked in the past week (exploratory outcome).[19,20] Previous study shows that the specific questionnaire administered to obtain information on blocks walked during the past week correlates with objectively measured physical activity level in people with PAD (correlation=0.25; $P<0.001$).[20]

The Walking Impairment Questionnaire

The Walking Impairment Questionnaire (WIQ) is a PAD-specific measure of self-reported limitations with 3 domains: walking distance; walking speed; and stair climbing.[21] Each domain is scored on a 0 to 100 scale, where 0 represents extreme limitation and 100 represents no difficulty walking long distances, walking rapidly, or climbing 3 stair flights, respectively.[21]

Quality of life

The physical (PCS) and mental health (MCS) composite scores from the Medical Outcomes Study 12-Item Short-Form Health Survey (SF-12) were used to assess global dimensions of health-related quality of life.[22] These measures were selected as outcomes because they were generic measures of quality

of life and our aim was to determine whether the intervention influenced this well-validated general measure of quality of life. The specific quality-of-life domains selected were more likely to change in response to the intervention than other Medical Outcomes Study 36-Item Short-Form Health Survey domains, based on the nature of the intervention.

Other Measures

Height and weight were measured at baseline.[7] Body mass index was calculated as weight (kg)/(height [meters])^2.

Randomization

Eligible participants were randomized by computer using a randomly permuted block method, stratifying by baseline 6-minute walk performance.[7]

Study Interventions

Phase I of the GMCB intervention (months 1 to 6)

As previously described, the GOALS intervention applied principles from social cognitive theory, the group dynamics literature, and research on self-regulation to motivate participants to adhere to home-based walking exercise.[23–25] During phase I (months 1 to 6) of the intervention, participants met once-weekly for 90 minutes in a group with other PAD participants and a trained facilitator. The facilitator led discussion on a different topic each week, including goal setting and self-monitoring.[7] Participants were instructed to engage in over-ground walking exercise at least 5 days per week at home, working up to 50 minutes per exercise session. Each week, participants recorded their walking goals on a study questionnaire. Participants were asked to record their actual walking exercise activity on this questionnaire each day. Primary outcomes were measured at 6-month follow-up, at the completion of phase I (Figure 1).

Phase I of the control group (months 1 to 6)

During phase I, participants assigned to the control group attended weekly educational group sessions with other PAD participants. Physicians and other healthcare professionals provided lectures on topics including managing hypertension, cancer screening, and vaccinations.

Phase II of the intervention and control groups (months 7 to 12)

During phase II (months 7 to 12), participants received regularly scheduled telephone calls from their group facilitator. For participants in the intervention, the telephone calls were designed to re-enforce self-regulation principals emphasized in phase I and encourage continued home-based exercise. As during phase I, participants were encouraged to walk over ground for exercise. Participants in the intervention were asked to record their daily walking exercise activity on the study questionnaire and mail these questionnaires back to study investigators. For participants in the control group, the telephone calls reviewed the health education topics covered during group sessions in phase I. For both groups, telephone calls in phase II occurred biweekly in months 7 to 9 and once-monthly in months 10 to 12. Telephone calls in each group lasted $\approx$10 minutes.

Sample-Size Calculations

Our prespecified comparison for 12-month outcomes was the change between baseline and 12-month follow-up. Power calculations for change in 6-minute walk between baseline and 12-month follow-up were based on power calculations for our primary outcome of change in 6-minute walk at 6-month follow-up and assumed that 100 people completing 6-month follow-up testing in each group would provide 80% power to detect a difference of 0.40 SDs of the pooled 6-month change in 6-minute walk distance between the exercise and control groups at the significance level of 0.05.[7] This difference corresponded to 21.6 m in the 6-minute walk using the estimated SD in our previous study of supervised exercise[2] and represents a small meaningful difference in the 6-minute walk test.[26] We expected that the improvements observed in the intervention group at 6-month follow-up would largely be maintained at 12 months and that participants in the control group would experience decline in their 6-minute walk between 6- and 12-month follow-up. Therefore, between-group differences in changes in functional performance from baseline to 12-month follow-up were expected to remain >0.40 SDs, and a sample size of 100 participants in each group was expected to provide sufficient statistical power. Comparisons between 6- and 12-month follow-up were not prespecified, and power calculations were not performed for these comparisons.

Statistical Analyses

Chi-square tests and 1-way ANOVAs were used to compare categorical and continuous characteristics of participants in the intervention and control groups, respectively, who completed 12-month follow-up testing. Two-sample, 2-sided *t* tests were used to compare changes in outcomes between baseline and 12-month follow-up between the intervention and the control group. These analyses were completed in exploratory analyses comparing changes in outcomes between 6- and 12-month follow-up. A priori, the *P* value considered statistically significant was $P<0.05$. Intention-to-treat analyses were performed. Specifically, all participants

were asked to return for follow-up measurements, regardless of their adherence to their assigned group. Decedents were excluded from analyses. We also performed multiple imputation analyses to adjust for missing data. We performed 2 sets of multiple imputation analyses: one in which decedents were excluded and one in which decedents were assigned a score of zero for follow-up measures. In addition, because participants attending the 12-month follow-up visit may no longer reflect the original randomization, we repeated analyses, adjusting for characteristics that appeared unbalanced between the intervention and control groups. In exploratory analyses, tests for statistical interactions were performed to determine whether presence versus absence of intermittent claudication influenced responsiveness to the study intervention. Analyses were performed using SAS statistical software (version 9.2; SAS Institute Inc., Cary, NC).

Results

We identified 194 eligible participants during the study recruitment period. Of the 194 participants randomized, 168 (86.6%) completed 12-month follow-up testing. Sixteen participants in the intervention group (including 3 decedents) and 10 in the control group (including 2 decedents) did not complete 12-month follow-up testing. Randomized participants who did not return for 12-month follow-up testing were younger (65.0±10.2 versus 71.0±9.3 years; P=0.003), compared to participants who returned for follow-up testing. Table 1 compares characteristics of participants randomized to the intervention and control conditions. As compared to the control group, those in the intervention were slightly younger, included more African Americans, and had a higher physical activity level at baseline (Table 1). However, only the difference in accelerometer-measured physical activity was statistically significant (P=0.048). Among 81 participants randomized to the intervention, 68 (84%) recorded their exercise data for at least 1 week during months 7 to 12. During months 7 to 12, the mean number of minutes walked for exercise was 207.7±118.9 min/week. In comparison, during months 1 to 6, the mean number of minutes walked for exercise was 195.0±98.1 min/week. Figure 2 shows 6-minute walk performance at each study time point in the

Table 1. Baseline Characteristics of the Intervention and Control Groups Among GOALS Participants Who Completed 12-Month Follow-up Testing*

Baseline Measures	Entire Cohort (N=168)	Control (N=87)	Intervention (N=81)
Age, y	71.0 (9.3)	72.0 (9.3)	69.9 (9.2)
Male, %	48.8	49.4	48.2
African American, %	48.2	41.4	55.6
Ankle brachial index	0.68 (0.17)	0.68 (0.18)	0.67 (0.16)
Body mass index, kg/m^2	28.9 (6.6)	29.0 (6.7)	28.7 (6.5)
Current smoker, %	21.4	18.4	24.7
Angina, %	15.0	15.1	14.8
History of myocardial infarction, %	13.7	13.8	13.6
History of heart failure, %	12.0	12.6	11.1
Stroke, %	13.1	17.2	8.6
Pulmonary disease, %	12.5	12.6	12.4
Cancer, %	16.2	17.4	14.8
Diabetes mellitus, %	33.9	36.8	30.9
Intermittent claudication symptoms, %	26.8	24.1	29.6
PAD participants without classic symptoms of intermittent claudication, %	73.2	75.9	70.4
Six-minute walk, m	354.2 (95.0)	353.1 (92.6)	355.4 (98.1)
WIQ distance score (0 to 100 scale, 100=best)	33.8 (26.7)	33.2 (26.3)	34.4 (27.2)
WIQ speed score (0 to 100 scale, 100=best)	35.5 (23.5)	34.9 (23.1)	36.1 (24.0)
WIQ stair climbing score (0 to 100 scale, 100=best)	48.2 (25.6)	46.8 (25.2)	49.7 (26.1)
Physical activity (activity units)	726.4 (374.0)	671.3 (335.4)	785.6 (404.3)

GOALS indicates Group Oriented Arterial Leg Study; PAD, peripheral artery disease; WIQ, Walking Impairment Questionnaire.
*Data shown are percentage values or means (standard deviations).

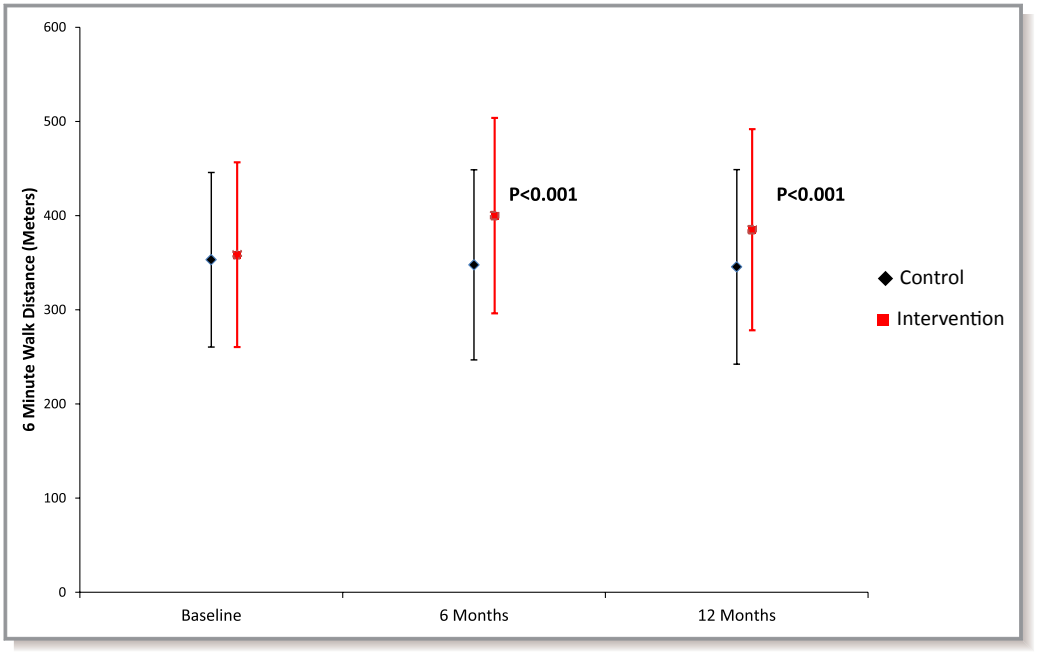

Figure 2. Six-minute walk distance in the Group Oriented Arterial Leg Study (GOALS) trial at baseline, 6-month, and 12-month follow-up according to group assignment. **P* values represent significant pair-wise comparisons in change from baseline between the intervention and control groups.

intervention and control groups. Six-minute walk performance was significantly better in the intervention, as compared to the control, group at both 6- and 12-month follow-up. At 12-month follow-up, participants in the intervention had significantly greater improvement in their 6-minute walk, compared to the control group (from 355.4 to 381.9 versus from 353.1 to 345.6 m, respectively; mean difference=+34.1 m; 95% confidence interval [CI]=+14.6, +53.5; *P*<0.001) (Table 2; Figure 2). These results did not substantially change in multiple imputation analyses. For example, in multiple imputation analyses in which decedents were excluded, participants in the intervention improved from 357.5 to 383.2 m and participants in the control group changed from 354.6 to 342.1 m (mean difference=+38.2; 95% CI=15.3 to 61.0). In multiple imputation analyses in which decedents were assigned a value of zero at follow-up, participants in the intervention improved from 354.6 to 371.3 m and participants in the control group changed from 352.2 to 335.0 m (mean difference=+33.9; 95% CI=8.5 to 59.4).

Figure 3 shows WIQ scores and accelerometer-measured physical activity levels in the intervention and control groups at baseline and at 6- and 12-month follow-up. Twelve-month change from baseline in the WIQ speed score was significantly greater in the intervention, as compared to the control group (36.1 to 46.5 versus 34.9 to 36.5; mean difference=+8.8; 95% CI=+1.6, +16.1; *P*=0.018). Twelve-month changes from baseline in the WIQ distance score, physical activity level, and the SF-12 PCS and MCS subscales, 6 months after the GMCB intervention was completed, were not different between the intervention and control groups (Table 2). For the exploratory outcome of change in blocks walked in the past week, participants randomized to the intervention achieved significantly greater gains, as compared to the control group, at 12-month follow-up, 6 months after the GMCB intervention was completed (from 18.0 to 36.6 versus 9.3 to 12.9; mean difference=+14.9; 95% CI=+0.2, +29.6; *P*=0.047). Results were not substantially changed when analyses were repeated using multiple imputation. However, in the multiple imputation analyses in which decedents were assigned a zero value at follow-up, 12-month change in the WIQ speed score was not different between the intervention and control groups (participants in the intervention improved from 35.1 to 44.7 m and participants in the control group changed from 33.8 to 36.6 m (mean difference=+6.8; 95% CI=−5.1 to +14.1). When analyses were repeated with adjustment for age, sex, race, and baseline physical activity level, the result for the outcome of 12-month change in physical activity level measured by accelerometer became nearly statistically significant (mean 12-month difference between the intervention and control groups=+114.1 activity units; 95% CI=−3.0 to +231.3; *P*=0.056) and the result for patient-reported blocks walked in the past week was no longer statistically significant (mean 12-month difference between the intervention and control groups=+12.6 blocks; 95% CI=−2.6 to +27.8; *P*=0.104).

In additional exploratory analyses, there was no statistically significant interaction between intervention assignment

Table 2. Changes Between Baseline and 12-Month Follow-up in Study Outcomes in the GOALS Trial According to Group Assignment

Twelve-Month Change in Outcome Measures	Group	N	Baseline, Mean (SD)	Twelve-Month, Mean (SD)	Within-Group Changes (95% CI)	Compared to Control (95% CI)	*P* Value for Comparison Between Baseline and 12 Months
Six-minute walk distance, m	Control	87	353.1 (92.6)	345.6 (103.3)	−7.6 (−21.1, +5.9)	Ref	0.001
	Intervention	81	355.4 (98.1)	381.9 (106.8)	+26.5 (+12.5, +40.5)	+34.1 (+14.6, +53.5)	
Physical activity measured over 7 days (activity units)	Control	84	673.2 (341.2)	652.0 (480.3)	−21.3 (−108.4, +66.1)	Ref	0.455
	Intervention	75	786.9 (414.0)	813.9 (355.5)	+27.0 (−65.5, +119.4)	+48.2 (−79.0, +175.4)	
WIQ distance score (0 to 100 scale, 100=best)	Control	85	32.8 (25.4)	36.3 (27.6)	+3.5 (−2.1, +9.2)	Ref	0.139
	Intervention	81	34.4 (27.2)	44.0 (30.8)	+9.6 (+3.8, +15.4)	+6.1 (−2.0, +14.2)	
WIQ speed score (0 to 100 scale, 100=best)	Control	87	34.9 (23.1)	36.5 (24.5)	+1.6 (−3.5, +6.7)	Ref	0.018
	Intervention	81	36.1 (24.0)	46.5 (24.7)	+10.5 (+5.2, 15.7)	+8.8 (+1.6, +16.1)	
WIQ stair climbing score (0 to 100 scale, 100=best)	Control	87	46.8 (25.2)	50.6 (28.4)	+3.8 (−1.1, +8.7)	Ref	0.246
	Intervention	81	49.7 (26.1)	57.7 (25.5)	+8.0 (+2.9, +13.0)	+4.1 (−2.9, +11.2)	
Physical component summary (PCS) from SF-12	Control	87	40.0 (5.1)	40.9 (5.4)	+0.9 (−0.5, +2.2)	Ref	0.900
	Intervention	81	40.6 (6.4)	41.6 (5.9)	+1.0 (−0.4, +2.4)	+0.1 (−1.8, +2.1)	
Mental component summary (MCS) from SF-12	Control	87	38.4 (5.6)	38.8 (7.3)	+0.5 (−1.1, +1.9)	Ref	0.350
	Intervention	81	39.4 (6.0)	38.8 (6.6)	−0.6 (−2.1, +1.0)	−1.0 (−3.2, +1.1)	
Patient-reported blocks walked in the past week	Control	87	9.3 (14.0)	12.9 (26.2)	+3.6 (−6.6, +13.9)	Ref	0.047
	Intervention	81	18.0 (38.2)	36.6 (58.3)	+18.5 (8.0, +29.1)	+14.9 (+0.2, +29.6)	

GOALS indicates Group Oriented Arterial Leg Study; SF-12, the Medical Outcomes Study 12-Item Short-Form Health Survey; WIQ, Walking Impairment Questionnaire.

and presence versus absence of intermittent claudication in their effect on study outcomes (data not shown).

Table 3 shows changes in study outcomes between 6- and 12-month follow-up exploratory comparisons. There were no significant differences in change in 6-minute walk, WIQ scores, physical activity level, or PCS or MCS scores between the intervention and control groups during the interval between 6- and 12-month follow-up. Within the intervention group alone, participants experienced a statistically significant decline in 6-minute walk between 6- and 12-month follow-up. These results suggest that gains achieved in the 6-minute walk and the WIQ speed score between baseline and 12-month follow-up are primarily related to benefits attained during phase I (months 1 to 6) of the GOALS trial. When analyses in Table 3 were repeated, adjusting for age, sex, race, and baseline accelerometer-measured physical activity, the intervention group had significantly greater decline in 6-minute walk performance between 6- and 12-month follow-up, compared to the control group (−17.8 m; 95% CI=−33.0 to −2.6; *P*=0.022).

Discussion

The GOALS randomized trial shows that a GMCB intervention consisting of weekly visits to an exercise center for 6 months in order to help PAD participants adhere to a home-based walking exercise program has persistent efficacy at 12-month follow-up. PAD participants randomized to the GOALS intervention had significantly greater improvement in the 6-minute walk and in the WIQ speed score at 12-month follow-up, 6 months after completing weekly on-site visits, compared to those randomized to the control group. To our knowledge, this is the first randomized, controlled clinical trial in people with PAD to report 12-month changes in walking-related outcomes, 6 months after completing an exercise intervention in which most of the walking exercise took place at home.

These results are important because people with PAD have significantly limited walking endurance and faster rates of functional decline and mobility loss, compared to people without PAD.[13,15,16,27,28] Yet, few medical therapies are available to improve walking in people with PAD. Of the 2 U.S. Food and Drug Administration (FDA)-approved medications for claudication, pentoxifylline (FDA approved in 1984) is not substantially better than placebo,[29] and cilostazol (FDA approved in 1999) provides only modest benefit.[30,31] Although supervised treadmill exercise significantly improves walking endurance in people with PAD,[1–4] supervised treadmill exercise is not usually paid for by medical insurance. Few people with PAD participate in supervised exercise programs.[5]

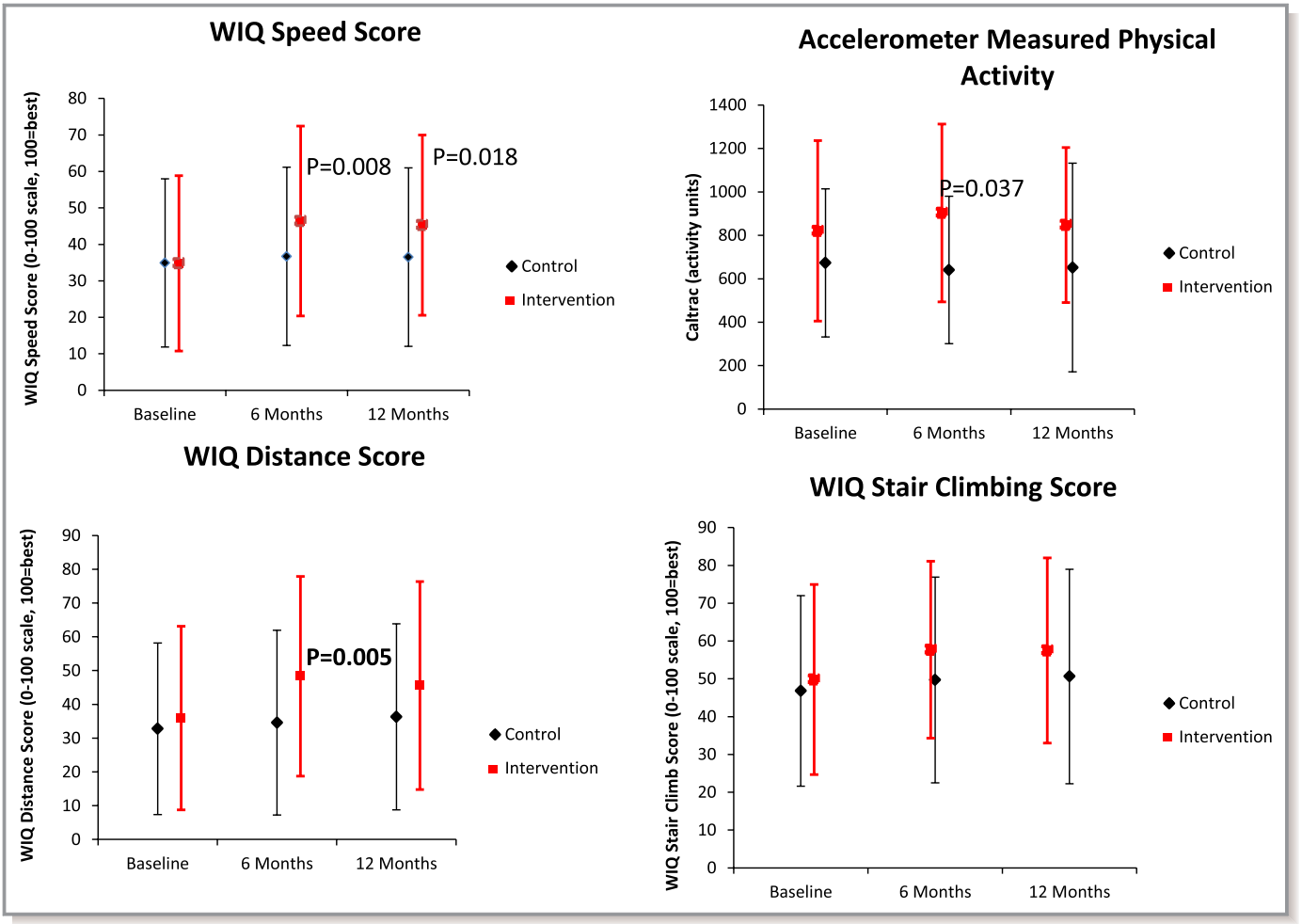

Figure 3. Outcomes in the GOALS trial at baseline, 6-month, and 12-month follow-up according to group assignment. **P* values represent significant pair-wise comparisons in change from baseline between the intervention and control groups. GOALS indicates Group Oriented Arterial Leg Study; WIQ, Walking Impairment Questionnaire.

Exercise programs that are less burdensome for PAD patients, encourage home-based walking exercise, and provide continued benefit during long-term follow-up are needed to help PAD participants avoid mobility loss and functional decline. In the GOALS randomized trial, the first 6 months of the intervention (phase I) required weekly visits to the medical center and the final 6 months (phase II) consisted of telephone contact only and did not require regular travel to the medical center.

Three clinical trials of home-based exercise in people with PAD completed in the late 20th and early 21st centuries were small and inconclusive.[32–34] Three recent randomized trials of home-based exercise in PAD with follow-up ranging from 3 to 6 months reported conflicting results.[6,35,36] First, Collins et al. randomized 145 participants with PAD and diabetes to either a home-based exercise program or a control group. The intervention consisted of a 1-hour instruction session at baseline and 2 exercise sessions with feedback on walking exercise and group interaction. Participants were subsequently asked to attend 1 group exercise session per week and walk for exercise at home at least 3 times weekly, using pedometers for self-monitoring. Participants also received biweekly telephone calls. However, at 6-month follow-up, the intervention and control groups did not differ in change in maximum treadmill walking distance. Second, Gardner et al. randomized 119 participants with PAD and IC to: (1) home-based walking exercise; (2) supervised treadmill exercise; or (3) control.[36] Participants in the home-based intervention were asked to walk 3 times weekly for 45 minutes per session, provided with a motion sensor to track their progress, and met with an investigator every 2 weeks to receive feedback. At 12-week follow-up, participants in the home-based intervention increased their maximal treadmill walking time by 31% and those in the supervised exercise intervention increased their maximal treadmill walking time by 66%. Each exercise group significantly increased their treadmill walking time, as compared to the control group.[36] However, study duration was only 12 weeks, the drop-out

Table 3. Changes in Study Outcomes Between 6- and 12-Month Follow-up in the GOALS Trial According to Group Assignment

Twelve-Month Change in Outcome Measures	Group	N	Six-Month Follow-up, Mean (SD)	Twelve-Month Follow-up, Mean (SD)	Six- to 12-Month Within-Group Changes (95% CI)	Twelve-Month Compared to 6-Month Follow-Up (95% CI)	*P* Value for Comparison Between 6- and 12-Month Values
Six-minute walk distance, m	Control	87	347.7 (101.0)	345.6 (103.3)	−2.2 (−12.6, +8.3)	Ref	0.095
	Intervention	81	396.8 (103.7)	381.9 (106.8)	−15.0 (−25.8, −4.1)	−12.8 (−27.9, +2.2)	
Physical activity measured over 7 days (activity units)	Control	84	640.6 (339.3)	652.0 (480.3)	11.4 (−56.7, +79.5)	Ref	0.186
	Intervention	75	869.2 (407.4)	813.9 (355.5)	−55.4 (−127.4, +16.7)	−66.8 (−165.9, +32.4)	
WIQ distance score (0 to 100 scale, 100=best)	Control	85	34.6 (27.3)	36.3 (27.6)	+1.7 (−3.4, +6.8)	Ref	0.224
	Intervention	81	46.8 (29.6)	44.0 (30.8)	−2.8 (−8.0, +2.4)	−4.5 (−11.8, +2.8)	
WIQ speed score (0 to 100 scale, 100=best)	Control	87	36.7 (24.4)	36.5 (24.5)	−0.2 (−4.9, +4.5)	Ref	0.780
	Intervention	81	47.7 (26.0)	46.5 (24.7)	−1.1 (−6.0, +3.7)	−1.0 (−7.7, +5.8)	
WIQ stair climbing score (0 to 100 scale, 100=best)	Control	87	49.7 (27.2)	50.6 (28.4)	+0.9 (−4.0, +5.9)	Ref	0.758
	Intervention	81	57.9 (24.3)	57.7 (25.5)	−0.2 (−5.4, +4.9)	−1.1 (−8.3, +6.0)	
Physical component summary (PCS) from SF-12	Control	87	39.9 (5.5)	40.9 (5.4)	+1.0 (−0.3, +2.2)	Ref	0.726
	Intervention	81	40.9 (6.0)	41.6 (5.9)	+0.7 (−0.6, +2.0)	−0.3 (−2.1, +1.5)	
Mental component summary (MCS) from SF-12	Control	87	38.6 (5.9)	38.8 (7.3)	+0.2 (−1.3, +1.7)	Ref	0.367
	Intervention	81	39.6 (5.8)	38.8 (6.6)	−0.8 (−2.4, +0.7)	−1.0 (−3.2, +1.2)	
Blocks walked in the past week	Control	87	14.0 (19.9)	12.9 (26.2)	−1.1 (−9.3, +7.1)	Ref	0.752
	Intervention	81	39.6 (46.5)	36.6 (58.3)	−3.0 (−11.5, +5.5)	−1.9 (−13.7, +9.9)	

GOALS indicates Group Oriented Arterial Leg Study; SF-12, the Medical Outcomes Study 12-Item Short-Form Health Survey; WIQ, Walking Impairment Questionnaire.

rate was 25%, and the investigators did not report on longer-term follow-up data. Third, primary outcomes of the GMCB intervention for the GOALS trial were measured at 6-month follow-up. At 6-month follow-up of GOALS, participants in the intervention achieved greater improvement in the 6-minute walk test, whereas the control group declined (+42.4 versus −11.4 m; $P<0.001$). At 6-month follow-up of GOALS, PAD participants also achieved significantly greater increases in the WIQ distance score, WIQ speed score, and accelerometer-measured physical activity, compared to the control group.[6] Our results reported here show that gains in the 6-minute walk and in the WIQ speed score are maintained at 12-month follow-up, 6 months after weekly on-site visits in the GOALS trial were completed.

Previous study demonstrates that benefits of supervised exercise training are not sustained after the supervised exercise program has been completed.[33] In contrast to supervised exercise, our GMCB intervention was designed to help patients with PAD overcome barriers to home-based walking exercise activity. Our GOALS intervention is similar to a previous intervention that achieved significant gains in long-term adherence to exercise in patients eligible for cardiac rehabilitation.[37] Our GMCB intervention incorporated self-regulation skills and group support to help PAD patients develop a regular habit of home-based walking exercise that could be sustained even after the weekly on-site GMCB intervention was completed. However, our results showed that not all gains achieved at the end of the 6-month GMCB intervention were sustained at 12-month follow-up. Specifically, significant improvements in physical activity level and the WIQ distance score observed at 6-month follow-up were not maintained at 12-month follow-up.

The reason for absence of a sustained benefit of our intervention on accelerometer-measured physical activity levels, despite a sustained benefit on 6-minute walk performance, is unclear. However, it is important to point out that the intervention had a sustained benefit on patient-reported physical activity, measured by the number of city blocks walked in the past week. It is possible that, over time, less physical activity was required to achieve a continued improvement in 6-minute walk performance. Further study is needed to determine the dose and intensity of exercise that achieves sustained improvement in functional performance in PAD.

The GOALS trial has limitations. First, results may not be generalizable to patients with PAD who did not meet our inclusion criteria. Second, the GMCB intervention required group support. Groups of patients with PAD can be difficult to assemble. Third, the GOALS trial included 6 months of on-site group meetings followed by 6 months of telephone contacts.

Our study design does not allow us to determine the degree to which the telephone contacts were important in maintaining home-based walking exercise behavior. Fourth, the first 6 months of the GOALS trial required weekly visits to the medical center and consisted of a somewhat complex intervention requiring group support and a facilitator. The once-weekly frequency of on-site visits and the complexity of the group intervention may not be easy to replicate in clinical practice. Further study is needed to determine whether the GOALS intervention is effective with fewer on-site visits. Fifth, our study design does not allow us to discern which components of the first 6 months of the intervention may have been responsible for the continued improvement observed at 12-month follow-up. Sixth, patient-reported blocks walked during the past week as a measure of physical activity at 12-month follow-up has limitations.

In summary, a 6-month walking exercise intervention that employed GMCB methods and encouraged regular home-based exercise continued to benefit PAD participants at 12-month follow-up. Further study is needed to determine whether continued benefits are observed beyond 12 months and to determine whether a more intensive intervention after the 6-month on-site GMCB intervention would achieve even greater improvement at 12-month follow-up.

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Disclosures

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References

1. Fakhry F, van de Luijtgaarden KM, Bax L, den Hoed PT, Hunink MMG, Rouwer EV, Spronk S. Supervised walking therapy in patients with intermittent claudication. *J Vasc Surg*. 2012;56:1132–1142.
2. McDermott MM, Ades P, Guralnik JM, Dyer A, Ferrucci L, Liu K, Nelson M, Lloyd-Jones D, Van Horn L, Garside D, Kibbe M, Domanchuk K, Stein JH, Liao Y, Tao H, Green D, Pearce WH, Schneider JR, McPherson D, Laing ST, McCarthy WJ, Shroff A, Criqui MH. Treadmill exercise and resistance training in patients with peripheral arterial disease with and without intermittent claudication: a randomized controlled trial. *JAMA*. 2009;301:165–174.
3. Watson L, Ellis B, Leng GC. Exercise for intermittent claudication. *Cochrane Database Syst Rev*. 2008:CD000990.
4. Gardner AW, Poehlman ET. Exercise rehabilitation programs for the treatment of claudication pain. A meta-analysis. *JAMA*. 1995;274:975–980.
5. Regensteiner JG. Exercise rehabilitation for the patient with intermittent claudication: a highly effective yet underutilized treatment. *Curr Drug Targets Cardiovasc Haematol Disord*. 2004;4:233–239.
6. McDermott MM, Liu K, Guralnik J, Criqui MH, Spring B, Tian L, Domanchuk K, Ferrucci L, Lloyd-Jones D, Kibbe M, Tao H, Zhao L, Liao Y, Rejeski WJ. Home-based walking exercise intervention in peripheral artery disease: a randomized clinical trial. *JAMA*. 2013;310:57–65.
7. McDermott MM, Domanchuk K, Liu K, Guralnik JM, Tian L, Ferrucci L, Kibbe M, Jones DL, Pearce WH, Zhao L, Spring B, Rejeski WJ. The Group Oriented Arterial Leg Circulation Study to improve walking performance in peripheral arterial disease. *Contemp Clin Trials*. 2012;33:1311–1320.
8. Amirhamzeh MM, Chant JH, Rees JL, Hands LJ, Powell RJ, Campbell WB. A comparative study of treadmill tests and heel raising exercise for peripheral arterial disease. *Eur J Vasc Endovasc Surg*. 1997;13:301–305.
9. Huen R, Papassotiropoulos A, Jennssen F. The validity of psychometric instruments for detection of dementia in the elderly general population. *Int J Geriatr Psychiatry*. 1998;13:368–380.
10. Shadman R, Criqui MH, Bundens WP, Fronek A, Denenberg JO, Gamst AC, McDermott MM. Subclavian artery stenosis: prevalence, risk factors, and association with cardiovascular diseases. *J Am Coll Cardiol*. 2004;44:618–623.
11. McDermott MM, Criqui MH, Liu K, Guralnik JM, Greenland P, Martin GJ, Pearce W. Lower ankle/brachial index, as calculated by averaging the dorsalis pedis and posterior tibial arterial pressures, and association with leg functioning in peripheral arterial disease. *J Vasc Surg*. 2000;32:1164–1171.
12. Criqui MH, Denenberg JO, Bird CE, Fronek A, Klauber MR, Langer RD. The correlation between symptoms and non-invasive test results in patients referred for peripheral arterial disease testing. *Vasc Med*. 1996;1:65–71.
13. McDermott MM, Greenland P, Liu K, Guralnik JM, Criqui MH, Dolan NC, Chan C, Celic L, Pearce WH, Schneider JR, Sharma L, Clark E, Gibson D, Martin GJ. Leg symptoms in peripheral arterial disease: associated clinical characteristics and functional impairment. *JAMA*. 2001;286:1599–1606.
14. McDermott MM, Ades PA, Dyer A, Guralnik JM, Kibbe M, Criqui MH. Corridor-based functional performance measures correlate better with physical activity during daily life than treadmill measures in persons with peripheral arterial disease. *J Vasc Surg*. 2008;48:1231–1237.
15. McDermott MM, Guralnik JM, Tian L, Ferrucci L, Liu K, Liao Y, Criqui MH. Baseline functional performance predicts the rate of mobility loss in persons with peripheral arterial disease. *J Am Coll Cardiol*. 2007;50:974–982.
16. McDermott MM, Tian L, Liu K, Guralnik JM, Ferrucci L, Tan J, Pearce WH, Schneider JR, Criqui MH. Prognostic value of functional performance for mortality in patients with peripheral artery disease. *J Am Coll Cardiol*. 2008;51:1482–1489.
17. Richardson MT, Leon AS, Jacobs DR, Ainsworth BE, Serfass R. Ability of the Caltrac accelerometer to assess daily physical activity levels. *J Cardiopulm Rehabil*. 1995;15:107–113.
18. McDermott MM, Ohlmiller SM, Liu K, Guralnik JM, Martin GJ, Pearce WH, Greenland P. Gait alterations associated with walking impairment in people with peripheral arterial disease with and without intermittent claudication. *J Am Geriatr Soc*. 2001;49:747–754.
19. Garg PK, Liu K, Tian L, Guralnik JM, Ferruci L, Criqui MH, Tan J, McDermott MM. Physical activity during daily life and functional decline in peripheral arterial disease. *Circulation*. 2009;119:251–260.
20. Garg PK, Tian L, Criqui MH, Liu K, Ferrucci L, Guralnik JM, Tan J, McDermott MM. Physical activity during daily life and mortality in patients with peripheral arterial disease. *Circulation*. 2006;114:242–248.
21. Regensteiner JG, Steiner JF, Panzer RJ, Hiatt W. Evaluation of walking impairment by questionnaire in patients with peripheral arterial disease. *J Vasc Med Biol*. 1990;2:142–152.
22. Ware J, Kosinski M, Keller SD. A 12-item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. *Med Care*. 1996;34:220–233.
23. Bandura A. Health promotion from the perspective of social cognitive theory. *Psychol Health*. 1998;13:623–650.
24. Cartwright DC. *Group Dynamics: Research and Theory*. New York, NY: Harper and Row; 1953.
25. Baumeister RF, Heatherton TF, Tice DM. *Losing Control: How and Why People Fail at Self-Regulation*. San Diego: Academic Press; 1994.
26. Perera S, Mody SH, Woodman RC, Studenski SA. Meaningful change and responsiveness in common physical performance measures in older adults. *J Am Geriatr Soc*. 2006;54:743–749.
27. McDermott MM, Liu K, Greenland P, Guralnik JM, Criqui MH, Chan C, Pearce WH, Schneider JR, Ferrucci L, Celic L, Taylor LM, Vonesh E, Martin GJ, Clark E. Functional decline in peripheral arterial disease: associations with the ankle brachial index and leg symptoms. *JAMA*. 2004;292:453–461.
28. McDermott MM, Greenland P, Liu K, Guralnik JM, Celic L, Criqui MH, Martin GJ, Schneider J, Pearce WH, Taylor LM, Clark E. The ankle brachial index is associated with leg function and physical activity: the Walking and Leg Circulation Study. *Ann Intern Med*. 2002;136:873–883.
29. Girolami B, Bernardi E, Prins MH, Ten Cate JW, Hettiarachchi R, Prandoni P, Girolami A, Buller HR. Treatment of intermittent claudication with physical

training, smoking cessation, pentoxifylline, or nafronyl: a meta-analysis. *Arch Intern Med*. 1999;159:337–345.

30. Dawson DL, Cutler BS, Meissner MH, Strandness DE Jr. Cilostazol has beneficial effects in treatment of intermittent claudication: results from a multi-center, randomized, prospective, double-blind trial. *Circulation*. 1998;98: 678–686.
31. Money SR, Herd JA, Isaacsohn JL, Davidson M, Cutler B, Heckman J, Forbes WP. Effect of cilostazol on walking distances in patients with intermittent claudication caused by peripheral vascular disease. *J Vasc Surg*. 1998;27:267–274.
32. Regensteiner JG, Meyer TJ, Krupski WC, Cranford LS, Hiatt WR. Hospital vs. home-based exercise rehabilitation for patients with peripheral arterial occlusive disease. *Angiology*. 1997;48:291–300.
33. Savage P, Ricci MA, Lynn M, Gardner A, Knight S, Brochu M, Ades P. Effects of home versus supervised exercise for patients with intermittent claudication. *J Cardiopulm Rehabil*. 2001;21:152–157.
34. Menard JR, Smith HE, Riebe D, Braun CM, Blissmer B, Patterson RB. Long-term results of peripheral arterial disease rehabilitation. *J Vasc Surg*. 2004;39:1186–1192.
35. Collins TC, Lunos S, Carlson T, Henderson K, Lightbourne M, Nelson B, Hodges JS. Effects of a home-based walking intervention on mobility and quality of life in people with diabetes and peripheral arterial disease. *Diabetes Care*. 2011;34:2174–2179.
36. Gardner AW, Parker DE, Montgomery PS, Scott KJ, Blevins SM. Efficacy of quantified home-based exercise and supervised exercise in patients with intermittent claudication. A randomized controlled trial. *Circulation*. 2011;123:491–498.
37. Rejeski WJ, Brawley LR, Ambrosius WT, Brubaker PH, Focht BH, Foy CG, Fox LD. Older adults with chronic disease: benefits of group-mediated counseling in the promotion of lifestyle interventions. *Health Psychol*. 2003;22: 414–423.